

Section 22

Excavation Operations

The requirements contained in this section apply to all types of excavation operations, except tunnels and shafts, covered in the section, "Tunnel and Shaft Construction." This section sets forth Reclamation's requirements for excavation operations. It covers the following specific areas:

- General Requirements
- Excavation Protective Systems
- Structural Footings
- Cofferdams

22.1 General Requirements for Excavation Operations

22.1.1 Preliminary Inspection. Before excavation, thoroughly inspect the site to determine conditions requiring special safety measures. Locate underground installations, such as sewer, telephone, gas, water, and electric lines. Make necessary arrangements with the utility company or owner to protect, remove, or relocate the underground installations. In such circumstances, excavate in a manner that does not endanger the underground installation or the employees engaged in the work. Protect utilities left in place by barricading, shoring, or suspending, or by other measures, as necessary.

22.1.2 Protect the Public. Provide necessary barricades, walkways, lighting, public awareness programs, and posting for the protection of the public before the start of excavation operations. Do not start excavation operations on or near State, county, or city streets or accessways or other locations where there is extensive interface with the public or motorized equipment until after you have the following:

- a. Written permission to proceed, together with protective measures required from the authority having jurisdiction (authority).
- b. An extensive and detailed Job Hazard Analysis (JHA), using the authority's instructions and these standards.
- c. A completed JHA, accepted by the designated authority.
- d. Proof that the JHA has been discussed with affected employees and the applicable protective measures are in place and functioning.
- e. Implementation of a public awareness program, when required by the contracting officer's representative or the office head.

22.1.3 Ingress and Egress. Provide safe access for employees, including installing walkways, ramps, stairs, and ladders.

- A competent person, qualified in structural design, must design the structural ramps used for ingress or egress of equipment. Make sure the structural ramps are constructed according to the design.
- To prevent displacement, connect the structural members of ramps and runways that are constructed of two or more structural members.
- Make sure structural members used for ramps and runways are of uniform thickness.
- Attach cleats (or other appropriate items used to connect runway structural members) to the bottom of the runway or in some other location or fashion that will not contribute to tripping.
- Provide structural ramps used in lieu of steps with cleats or other surface treatments on the top surface to prevent slipping.

Where employees must enter trenches more than 4 feet (1.22 meters) deep, provide stairs, ladders, or ramps at intervals of no more than 25 feet (7.62 meters) of lateral travel. When access to excavations is more than 20 feet (6.10 meters) vertically, provide ramps, stairs, or personnel hoists.

22.1.4 Lighting. Provide either natural or artificial lighting at excavation sites, borrow pits, and waste areas in accordance with illumination requirements.

22.1.5 Personal Protective Equipment. Provide personal protective equipment in accordance with the specific requirements in the section, "Personal Protective Equipment" and make sure that employees use the equipment when it is needed. Protect employees exposed to occupational health hazards. Drillers and helpers must wear approved safety goggles or safety glasses with side shields, hearing protection, and safety shoes, as required.

22.1.6 Removal of Surface Encumbrances. Before excavation, remove trees, brush, boulders, and other surface encumbrances that may present a hazard to employees.

22.1.7 Inspections. Each day, make sure that a competent person does the following:

- a. Inspects excavations, the adjacent areas, and protective systems for warning signs of a situation that could result in possible cave-ins, indications of failure of protective systems, hazardous atmospheres, or other hazardous conditions. The competent person

must conduct an inspection before the start of work and as needed throughout the shift. Make inspections following every rainstorm or other hazard-increasing event.

b. If the competent person finds: (1) evidence of a situation that could result in a cave-in; (2) indications of failure of protective systems; (3) hazardous atmospheres; or (4) other hazardous conditions, remove exposed employees from the hazardous area until the necessary precautions are made to ensure their safety.

22.1.8 Structure Foundations and Footings. Except in hard rock, do not permit excavations below the level of the base of any foundation, footing, or retaining wall, unless the wall is underpinned and all necessary precautions are taken to ensure the stability of the adjacent walls. Install shoring, bracing, or underpinning designed by a qualified person if the excavation endangers the stability of adjacent buildings or structures. Have a qualified person inspect such supporting systems at least daily to ensure that the protection is adequate and effectively maintained.

22.1.9 Vertical Cuts and Slopes. Protect employees working below or on slopes or cuts exposed to falling, rolling, or sliding rocks, earth, or to other materials in the following manner:

- a. **Scaling.** Effective scaling must be performed before exposure and at intervals necessary to eliminate the danger.
- b. **Rock Bolting.** Install rock bolting, wire mesh, or equivalent support when material continues to ravel and fall, even after thorough scaling.
- c. **Barricades.** Installing protective timber or wire mesh barricades at the top of the cut and at necessary intervals down the slope.
- d. **Benching.** Use benching, wherever practical, sufficient to retain falling material instead of barricades.
- e. **Placing Personnel.** Do not permit personnel to work above one another where danger of falling rock or earth exists. Protect personnel performing work on vertical cuts or slopes, where balance depends on a supporting system. Use appropriate fall protection.

22.1.10 Supporting Materials. Make sure materials used for sheeting, piling, cribbing, bracing, shoring, and underpinning are in good serviceable condition and timbers are sound and free of large or loose knots.

22.1.11 Backfilled Excavation. Take special precautions in sloping or shoring the sides of excavations adjacent to a previously backfilled excavation or fill area. Do not use compacted

backfill as backforms on slopes steeper than 34 degrees measured from the horizontal (1-1/2 horizontal to 1 vertical), unless specified by a design approved by a professional engineer (PE) and properly documented in writing.

22.1.12 Groundwater. Control groundwater. Use a PE to plan and direct freezing, pumping, drainage, and other major control measures. Give full consideration to the existing moisture balances in surrounding soils and the effects on foundations and structures if the moisture balances are disturbed. Provide an emergency power source when continuous operation of groundwater control equipment is necessary.

22.1.13 Surface Water. Do not allow water to accumulate in excavations. Use diversion ditches, dikes, dewatering sumps, or other effective means to control surface water.

22.1.14 Crossovers. Provide walkways or bridges protected by standard guardrails where employees are required or permitted to cross over excavations.

22.1.15 Undercuts. When necessary to undercut a slope or vertical cut, adequately support the residual material. Submit the undercutting method and support system to the contracting officer's representative and be sure that it is accepted. If Reclamation employees conduct the work, submit the undercutting method and support system to the office head for acceptance before starting undercutting operations.

22.1.16 Excavated Materials. Place excavated materials and retain at least 2 feet (0.61 meter) from the edge of the excavation or at a greater distance when required to prevent hazardous loading on the face of the excavation.

22.1.17 Protective Devices. Maintain guardrails and fences, barricades and warning lights, or other illumination systems from sunset to sunrise on excavations adjacent to walkways, driveways, and other pedestrian or vehicle thoroughfares. Effectively barricade or cover and post wells, subsurface exploration holes, pits, shafts, and all similar hazardous excavations. Backfill as soon as possible all temporary excavations at these locations.

22.1.18 Stoplogs. When mobile equipment is permitted adjacent to excavations with steep slopes or cuts, install substantial stoplogs or barricades.

22.1.19 Exposure to Vehicular Traffic. Provide employees exposed to public vehicular traffic with warning vests or other suitable garments marked with, or made of, reflectorized or high-visibility material.

22.1.20 Equipment Operation. Provide equipment operating on loading or waste areas with an automatic backup alarm. Additionally, use a competent signalman to direct traffic when employees are on foot or otherwise endangered by equipment in dumping or waste

areas. Do not give the signalman any other assignment that could interfere with signaling duties. If the equipment or truck cab is not shielded, the operator must stand clear of the vehicle during loading. Do not allow excavating or hoisting equipment to raise, lower, or swing loads over workmen unless you provide effective overhead protection.

22.1.21 Hazardous Atmospheres. In locations where oxygen deficiency or gaseous conditions are known or suspected, test the air in the excavation before the start of each shift or more often if directed by the designated authority. Maintain a log of all test results at the site. If the oxygen level is less than 19.5 percent, the concentration of flammable gas exceeds 10 percent of the lower flammable limit, or toxic materials exist at levels exceeding the Threshold Limit Value (TLV), take steps such as increasing the ventilation to control the hazards.

22.2 Requirements for Excavation Protective Systems

22.2.1 Sloping and Benching. Slope or bench all excavations 5 feet (1.52 meters) or more deep in accordance with one of the systems outlined below.

- a. For excavations less than 20 feet (6.10 meters) deep, the maximum slope is 34 degrees, measured from the horizontal (1-1/2 horizontal to 1 vertical), unless one of the other options listed in this subsection are used.
- b. Determine the maximum allowable slope and benching systems according to the conditions and the requirements set forth in OSHA 1926, subpart P.
- c. Select the design according to written tabulated data, such as charts and tables. Maintain at least one copy of the tabulated data at the jobsite during excavation. Include the following tabulated data:
 - Identification of the parameters that affect the selection of a sloping or benching system drawn from the data
 - Identification of the limits of use of the data, including the magnitude and configuration of slopes determined to be safe
 - Explanatory information as may be necessary to help the user correctly select a protective system from the data
 - The PE who approved the data

d. Use a PE to design the sloping or benching system. Maintain at least one copy of the design at the jobsite during excavation. Designs must be in writing and must include:

- The magnitudes and configurations of the slopes that were determined to be safe for the particular excavation
- The identity of the PE who approved the design

22.2.2 Support Systems. Use a PE to design sheeting, sheet piling, bracing, shoring, trench boxes, and other methods of excavation and trench protection. Use qualified personnel to install excavation and trench protection. Designs must be in writing and must include the following:

- A plan indicating the sizes, types, and configurations of the materials to be used in the protective system
- The identity of the PE approving the design

Maintain at least one copy of the design at the jobsite.

22.2.3 Shoring Design Requirements. Design criteria support systems or shoring must meet or exceed the minimum requirements set forth in this subsection and in OSHA 1926, subpart P. Do not subject braces and diagonal shores in a timber shoring system to compressive stresses in excess of the values given in the following formula:

$$S = 1300 - \frac{20L}{D}$$

$$\text{maximum ratio } \frac{L}{D} = 50$$

where:

- L = length, unsupported, in inches
- D = least dimension of timber, in inches
- S = allowable stress of cross section, in pounds per square inch

22.2.4 Shoring, Sloping, Benching, Trench Box Illustrations. Figures in OSHA 1926, subpart P, tentatively illustrate the basic shoring, sloping, benching, trench box, and shield requirements contained in this subsection.

22.2.5 Trench Boxes and Shields. The designated authority may authorize portable trench boxes, sliding trench boxes, or shields instead of required sloping, benching, or supporting methods when:

- a. A PE designs the boxes or shields, which provides protection equivalent to shoring and sheeting for the same condition and conform to requirements of OSHA 1926, subpart P.
- b. The boxes or shields are constructed and maintained to design standards.
- c. A job hazard analysis covering operation and maintenance of the boxes or shields has been developed, and affected employees have been trained and instructed on the effective use of the protective equipment.
- d. Backhoes, excavators, and cranes used to move trench boxes and shields meet the applicable requirements in the section on "Hoisting Equipment, Piledrivers, and Conveyors."

22.2.6 Benching. Benching excavation procedures may be used to accommodate operations such as pipelaying (see 29 CFR 1926, Subpart P, Appendix B).

22.2.7 Placing Shoring, Trench Boxes, or Shields. Carry shoring, trench boxes, or shields along with the excavation, and do not omit them where the depth of trench or soil conditions require shoring or bracing. Where a backhoe or ditching machine is used, place the shoring box or shield as close as possible to the lower end of the boom. Excavations may extend 2 feet (0.61 meter) below the bottom of shoring, trench boxes, or trench shields, provided the protective systems are designed to resist the forces calculated for the full depth of the trench and there are no indications, while the trench is open, of a possible loss of soil from behind or below the bottom of the support system.

22.2.8 Removal of Support. Backfilling and removing trench support systems must progress together from the bottom of the trench. Release jacks and braces slowly. In unstable soil, use ropes or other safe means to remove the braces from the surface after the employees have left the trench.

22.2.9 Cross Braces and Jacks. Place cross braces and trench jacks in true horizontal position and secure them to prevent sliding, falling, or kickouts.

22.3 Requirements for Structure Footings

22.3.1 Casing Requirements. Provide a steel casing or support system of sufficient strength to support the earth walls and prevent cave-ins in small diameter footings, including

bell-bottom footings over 4 feet (1.22 meters) deep, that employees must enter. Provide the casing or support system the full depth, except for the bell portion of bell footings.

22.3.2 Access Requirements. Provide fixed or portable ladders for access. Every employee entering the footing must wear a lifeline securely attached to a shoulder harness. Man the lifeline from above and separate it from any line used to raise or lower materials.

22.4 Requirements for Cofferdams

22.4.1 Controlled Flooding. Provide for controlled flooding of the work area in any design if overtopping of a cofferdam is possible. Devise an evacuation plan, including installation of warning signals and emergency exits, to safely evacuate employees and equipment from the work area.

22.4.2 Walkways and Guardrails. Where employees are permitted on cofferdams, install safe walkways protected by guardrails.

22.4.3 Exit. Provide a rapid means for employees who work on cofferdams to exit with their equipment.